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PICKING MATURITY OF APPLES IN RELATION TO STORAGE

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INTRODUCTION

The time of picking of different apple varieties has a very marked bearing upon the manner in which these varieties hold up in storage. With many varieties there is a tendency on the part of the growers to pick the fruit too early, resulting in excessive development of storage scald, shriveling in storage, and oftentimes a poor dessert quality. With other varieties the storage quality would be greatly improved by picking the fruit even somewhat earlier than is now generally practiced. The best time for picking any variety will also vary somewhat with the storage treatment the fruit is to receive.

Each individual variety is a problem in itself in regard to the best time for removing the fruit from the tree. Whether or not a variety tends to develop storage scald or whether it breaks down in storage through becoming overripe and mealy or shows breakdown in the flesh are important factors in determining when to pick the fruit. Oftentimes the best condition for picking will vary in the same variety, depending upon the climatic conditions prevailing in different parts of the country.

During the last four years investigations have been carried on relative to the changes which occur in several varieties of apples as they ripen on the tree as well as to the behavior of the fruit while being held in storage following picking. The detailed results of a portion of these investigations have been reported in a recent publication.[1]

[1] MAGNESS, J. R., and others. THE RIPENING, STORAGE, AND HANDLING OF APPLES. U. S. Dept. Agr. Bul. 1406, 64 p., illus. 1926.

Because of the many varying factors which enter into a determination of the best time for picking different varieties and the variation in the tests for best time of picking, it is believed that a detailed discussion of the matter as it relates to the main commercial apple varieties might well be dealt with in a separate bulletin.

The ripening process in apples consists of numerous changes which take place more or less together, but which may also vary somewhat in their relation to one another. The changes which occur in apples as they ripen on the tree have been dealt with in some detail in a previous publication.[2] Since the discussion in this bulletin will deal very largely, however, with the application of these changes to the time of harvesting of different commercial varieties, it is essential that they be reviewed in this connection.

CHANGES IN APPLES AS THEY APPROACH PICKING MATURITY

INCREASE IN SIZE

Studies on six varieties of apples when growing in various parts of the country have shown [2] that as long as the apples are holding on to the tree a very nearly uniform rate of growth in size continues. Thus, delaying the picking of the apple crop will result in somewhat larger sized fruit. In the tests carried on, the volume of the fruit on the tree increased about 6 to 8 per cent during the 10 days immediately preceding best picking condition. The individual apples, then, are larger if late picking is practiced. A very considerable drop must occur prior to picking before the total tonnage will be materially decreased, as compared with that obtained from earlier picking.

COLOR OF SEEDS

The browning of the seeds in apples as they approach picking maturity has often been suggested as an index for the best time for picking the fruit. The seeds of the winter apples, however, usually become brown a considerable period prior to the optimum picking date. The time of the coloring of the seeds in relation to the maturity of the fruit varies so greatly with the variety and season that this change is of little value in determining when to pick the fruit. It may be stated, however, that winter apples are practically never ready to pick before the seeds have reached a full brown color.

CHEMICAL COMPOSITION

There are marked changes in the chemical composition of apples as they approach picking maturity. In general, as the fruit ripens on the tree the astringent substances, including tannin, tend to decrease, the acidity of the fruit decreases, and there is an increase in sugar content. Because of the wide variations which exist in the chemical composition of apples, aside from those induced by ripening, a chemical test for time of picking appears to be of little practical value. The quantity of sugar will vary with the quantity

[2] MAGNESS, J. R., and DIEHL, H. C. PHYSIOLOGICAL STUDIES ON APPLES IN STORAGE. Jour. Agr. Research 27 : 1–38, illus. 1924.

of fruit on the tree, the moisture supply, and climatic conditions, as well as with degree of maturity. The sugar content of fruit from heavily loaded trees will be below that of fruit from lightly loaded trees under similar growing conditions and in a similar stage of maturity.[3] The recent work of Caldwell [4] indicates that during seasons of high sunlight the sugar content of apples will be higher than in seasons of low sunlight. These changes in chemical composition due to variations in growing conditions are so great in relation to those due to stage of maturity in apples that any picking test based on chemical composition would prove unsatisfactory.

CORKING OVER OF THE LENTICELS

The lenticels or pores in the skin, which in the immature fruit open more or less directly to the flesh tissue below, become filled with cork cells and sealed over as the fruit approaches maturity on the tree. This change is of much importance in retarding wilting and the moisture loss from the fruit. The waxy coating on the surface of the fruit also develops during the latter part of the growing season. The development of the heavy wax coating and the sealing of the lenticels result in the fruit which is well matured at picking time being much more resistant to wilting in storage than that which is picked in an immature condition. These changes, although important from the storage viewpoint, are not sufficiently discernible to make them of much value in determining when the fruit should be removed from the tree.

CHANGE IN COLOR

The change in color of apples as they mature on the tree is twofold. There is a direct development of the red color in blushed or colored varieties, while in the unblushed portions of the immature fruit the green color changes to a greenish yellow and finally to almost a full yellow color. The development of red color is a tremendously important factor in determining when to pick apples for commercial purposes, since high color is essential to the advantageous marketing of many varieties. The development of red color depends very largely, however, upon the exposure of individual fruits to sunlight and upon the prevalence of bright, sunny days during the ripening season. The sugar content of the fruit also appears to be an important factor in color development. Consequently, red color is not an accurate index to the actual condition of maturity of the fruit, since fruit borne in the shade or on trees producing a very heavy crop may be in the best picking condition while showing relatively little red color.

The disappearance of the green color in the unblushed portion of apples is largely independent of light exposure and in many varieties affords an excellent index of the time when the fruit is ready to remove from the tree. The methods of estimating this color change and its relation to picking season in the different varieties are discussed in detail below.

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[3] HALLER, M. H., and MAGNESS, J. R. RELATION OF LEAF AREA TO SIZE AND CHEMICAL COMPOSITION OF APPLES. Amer. Soc. Hort. Sci. Proc. 1925.

[4] CALDWELL, J. S. EFFECT OF CLIMATIC CONDITIONS UPON CHEMICAL COMPOSITION OF APPLE JUICES. [Unpublished manuscript.]

SOFTENING OF THE FRUIT

Another change which in many varieties, and particularly under certain growing conditions, affords a good index to the picking condition of the fruit is the softening of the flesh of the apple. Softening is the outstanding change in apples as they ripen in storage. Also, there is usually a distinct softening as the fruit approaches maturity on the tree, though the apple may be so firm at this time that the condition is not readily apparent unless measured mechanically. Although the rate of softening of apples attached to the tree is relatively slow, the measurement of the firmness of the flesh is of much value, particularly in determining when certain varieties are becoming so ripe that their storage quality is being impaired.

LOOSENING OF FRUIT ON THE TREE

Another very useful method for determining when fruit is ready to remove from the tree is based on the manner in which the fruit adheres to the tree. Most varieties of apples as they approach proper picking condition tend to loosen from the spur, so that when the fruit is lifted the stem readily separates. This test, which is very generally used for determining the time for picking apples, is very valuable for many varieties, but with certain varieties and under certain conditions is much less satisfactory.

THREE MAIN FACTORS

After a careful study of all the changes which occur in apples as they approach picking maturity, it thus appears that the three factors of greatest value in determining when to pick the fruit are (1) the degree of yellowing in the unblushed or uncolored portion of the fruit, (2) the firmness of the flesh of the fruit, and (3) the way the fruit is holding on to the tree or the ease with which it may be picked. The relative value of these different tests will vary with different varieties and with the same variety grown in different parts of the country.

METHODS FOR DETERMINING CHANGES INDICATING PROPER TIME FOR PICKING

For determining the rate of yellowing in the uncolored portions of apples the color chart reproduced in Plate 1 has been used. These colors closely approximate the color stages through which apples pass as they ripen on the tree and in this form may prove of value to apple growers in following the changes in the ground color of different varieties from season to season. A circular hole about three-fourths of an inch in diameter should be cut in the center of each of the four colors on the chart with which it is desired to compare the color of the fruit. The fruit should be placed back of the chart and the unblushed portion fitted into the holes cut in the different colors. By this means it is possible to obtain the same light exposure on the fruit and on the color chart, and they can thus be accurately compared. The best matching of color is obtained by making the comparison in daylight in the shade. Direct sunlight or artificial light appears to make a slight difference in the comparative values

1

2

3

4

of the colors. The four colors, numbered from 1 to 4, have been found satisfactory for general use on apples. When the color of an apple falls between two of the standard shades given it can be noted, for example, as "between 3 and 4" or as 3½. A greater number of colors would make the comparison more difficult and would add little to the accuracy of matching the fruit color.

The firmness of the flesh of the fruit can be most accurately measured by the use of a pressure-test apparatus. Such an apparatus with methods for its use has been described previously [5] and is now available on the market. This apparatus measures in pounds the pressure required to force a plunger seven-sixteenths of an inch in diameter into the apple to a depth of five-sixteenths of an inch, the skin being removed prior to making the test. Figure 1, reproduced from Department Circular 350, illustrates the method of making the test. The fruit to be tested is placed against any convenient solid surface, such as a wall, or the trunk of a tree if the test is being made in an orchard. The plunger tip is placed in contact with the cut surface and pressure is applied. When the plunger tip has pene-

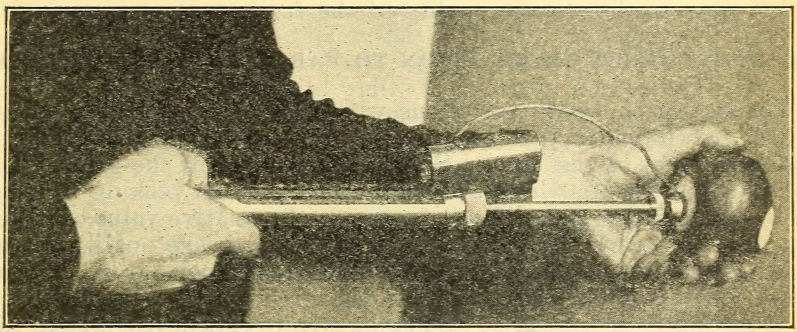

FIG. 1.—Fruit pressure tester, showing method of its use in testing an apple

trated to a depth of five-sixteenths of an inch an electric contact is made which lights the small flashlight attached to the instrument. The amount of pressure in pounds required to force the plunger into the fruit to this depth is then read directly on the scale. In order to obtain a satisfactory indication of the condition of any variety at least 10 to 20 apples selected from different trees and different parts of the trees should be used. Two or more tests may be made on each apple and the results averaged. Tests should be made within a few hours following picking.

The tenacity with which the fruit adheres to the tree can be estimated only in a general way. If the stem of sound fruit separates from the spur when the fruit is lifted or is given a slight twist, it would be considered that the fruit is loosening on the tree and separates easily. Under this condition it is probable that a small amount even of sound fruit may be dropping. If no fruit is dropping and if the fruit can be picked only with considerable effort, it is considered that the fruit is still firmly attached to the tree. The dropping of

[5] MAGNESS, J. R., and TAYLOR, G. F. AN IMPROVED TYPE OF PRESSURE TESTER FOR THE DETERMINATION OF FRUIT MATURITY. U. S. Dept. Agr. Circ. 350, 8 pp., illus. 1925.

wormy or otherwise injured fruit is not an indication of picking maturity.

The development of water core in the fruit is a very important consideration in determining when to pick certain varieties. Recent investigations by Brooks and Fisher [6] have shown that water core usually develops first in fruit exposed to the direct sunshine on the south and west sides of the trees. Consequently, in looking for the appearance of water core in any variety, apples from the exposed south or west and top portions of the tree should be examined. If water core is not found or if it is present in only a slight degree in fruit from these positions on the tree, it is improbable that it will be present to an injurious extent in fruit from more protected portions of the tree.

Water core in appreciable extent seriously injures the storage quality of varieties which ripen rapidly in storage, such as Jonathan, Delicious, and Winter Banana. With the slower softening, longer keeping varieties, such as Rome Beauty, Winesap, and Yellow Newtown, a small amount of water core in fruit at picking time will apparently disappear while the fruit is in storage, without appreciable injury to the storage quality of the fruit.

TIME OF PICKING IN RELATION TO VARIETY CHARACTERISTICS

Because of the wide variations which occur in the same variety when grown under the varying climatic conditions prevailing in different parts of the United States, and because of the great variations in the factors which determine the optimum picking time for different varieties, it is difficult to discuss the relative value of different tests for apple varieties in general. The storage quality of certain varieties is greatly reduced by leaving the fruit on the tree too long, whereas with other varieties the greatest harm results from picking the fruit too early. Consequently it is believed best to discuss the merit of these different tests for time of picking and the best time for picking different varieties in detail in connection with the various commercial apples. Only those varieties are included which have been studied sufficiently for the writers to feel fairly certain of the dependability of their observations and tests and of the recommendations made.

In the following discussion reference is repeatedly made to the susceptibility of varieties to storage scald in relation to the best picking date. It should be pointed out that in the box-packing districts fruit of these scald-susceptible varieties is nearly always wrapped in oiled paper, which almost entirely controls scald. The use of oiled paper in barrels and baskets is increasing and serves to lessen greatly the probability of fruit scald in these packages. If oiled paper is not used, however, and even when it is used on the more susceptible varieties, particularly when they are packed in barrels, the susceptibility of the variety to storage scald is an important consideration in determining when to pick. It is a definitely established fact that well-matured and well-colored fruit of the susceptible varieties will scald much less than will that harvested in a somewhat immature condition.

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[6] Brooks, C., and Fisher, D. F. water-core of apples. Jour. Agr. Research 32 : 223–260, illus. 1926.

Reference is also made to the approximate number of days required for different varieties to reach full picking maturity on the tree. These data are based on observations of the time required between full bloom and the best time for picking the fruit. The date of full bloom has been taken as the date when the first petals fall. At this time some blossoms will be just opening and others will be shedding their petals. Data so far obtained indicate that there is a fairly close relation between the time of full bloom in different varieties and the best picking date.

ARKANSAS

The storage life of the Arkansas (*Mammoth Black Twig*) is limited very largely by the development of storage scald. This is particularly true if the fruit is held in cold storage without the use of oiled paper in the package. The variety is usually firm at time of picking and ripens relatively slowly in storage, hence there is little danger that the fruit will become too ripe, particularly if it is placed in cold storage promptly and is held at temperatures of 31° to 32° F. It requires a long growing season, usually over 160 days, to reach its best development on the tree. Since well-matured fruit scalds least in storage, the later that Arkansas is picked the better the storage quality will be. Fruit of this variety should remain on the tree as long as it will hold well. If the fruit is to be held in cold storage, late picking results in larger fruit of better color and with less tendency to scald; if to be held in common or air-cooled storage, late picking will result not only in larger size, better color, and less tendency to scald, but the late-picked fruit will also be firmer at any time during the storage season. The fruit of this variety, in common with most late-ripening apples, softens faster after being picked and while being held at the temperatures prevailing in air-cooled storage than while remaining attached to the tree. Thus, the later the fruit is picked the firmer will be its condition if held in air-cooled storage.

The tendency to drop or the possibility of freezing weather will determine when the variety should be picked. The pressure test will usually be near 20 pounds when the tendency to drop necessitates picking this variety. The unblushed portion of the fruit should correspond to No. 3, Plate 1, unless the tendency to drop necessitates picking before this stage is reached.

ARKANSAS BLACK

Arkansas Black is a very firm variety, softening extremely slowly in storage. It is one of the hardest of the commercial varieties, usually testing near 25 pounds when in picking condition.

The Arkansas Black colors very highly and has only a slight tendency to develop storage scald. There is little danger of its becoming so ripe on the tree that the storage quality will be injured. The fruit should be a full deep-red color when picked and should separate readily from the spur. For common-storage holding, the variety should be picked as late as possible, since it will ripen less while attached to the tree than while being held in storage at prevailing temperatures. For common-storage holding, the tendency to drop or the possible imminence of severe freezing weather will determine

when the variety should be picked. For cold-storage holding, the variety may be picked when fully colored and when showing a ground color corresponding to Nos. 3 and 4, Plate 1.

BALDWIN

The Baldwin usually reaches picking maturity in about 140 to 145 days from date of bloom. Thus, in the southern apple-growing regions the picking date will usually fall in September, and in the north-central and northeastern apple sections with a much later bloom the harvest will normally fall in late October. In the South, since this variety ripens during hot weather, it must be handled in cold storage if an appreciable holding period is desired. In the short-season growing districts, to which the Baldwin is best adapted, districts having later harvest and a cooler fall, the variety can be held very successfully until midwinter or later in common storage.

The Baldwin, as grown in the South, scalds rather badly in storage, but this tendency is much less pronounced in fruit from the more desirable Baldwin sections of the North and East. The Baldwin has a marked tendency to drop as soon as or in some cases before the fruit reaches best picking condition. This tendency largely determines the time of picking of this apple. So long as the apples are holding on the tree well they may be left with safety. When the fruit begins to loosen and separate easily from the spur, however, it is necessary to harvest it to avoid excessive loss in tonnage.

The Baldwin in the southern districts will usually show a pressure test of 18 to 19 pounds when in good picking condition. In the north-central and northeastern sections the pressure test will usually run from 19 to 22 pounds. Color is relatively undependable as an index to maturity in Baldwin. The ground color will vary from No. 2 to No. 4, Plate 1, in fruit grown under different cultural and climatic conditions.

In the northeastern apple sections where the Baldwin is adapted to common-storage holding, relatively late picking has been found to give firmer and better common-storage fruit than does early picking. The fruit softens less while on the tree than if picked and held at prevailing common-storage temperatures; hence leaving the fruit on the tree is preferable to early picking. The fruit is not only firmer in storage as a result of later picking, but is also larger, better colored, and less likely to develop scald.

With the Baldwin the tendency to drop is the best indication of when it is in proper picking condition. It frequently happens that the variety starts to drop relatively early in the fall, particularly in seasons following an early bloom. In this case early picking is essential to avoid excessive loss, and the fruit is much less satisfactory for common-storage holding. If placed promptly in cold storage, however, it will hold through a normal storage season.

BEN DAVIS

In the eastern half of the United States the Ben Davis is grown commercially over an extremely wide range of climatic conditions from south to north. The condition of the fruit at picking time will

vary somewhat in these different sections, particularly so far as the firmness of the flesh is concerned.

Probably this variety is handled more extensively than any other in common storage. The fruit holds late on the tree with little dropping, consequently it is usually well matured when picked, and relatively little scald develops during storage. If picked in an immature condition, however, the variety often shows extremely severe scald development.

Ben Davis usually requires about 155 to 160 days between the blooming season and the time of best picking conditions. Thus in the northeastern apple districts it will usually be the last variety picked, and in the more southern apple sections the normal season will fall in early October.

This variety should not be picked before the ground color reaches the almost full yellow condition shown in No. 4, Plate 1. The fruit should also be highly colored. When this condition is reached in the southern sections the pressure test will usually be 17 to 18 pounds, whereas in the more northern districts it will be 19 to 20 pounds.

If fruit from the southern sections is left on the tree until softer than a condition represented by a pressure test of about 17 pounds, relatively poor storage fruit will be obtained. Fruit of this variety when picked in a more mature condition than this will become soft relatively early in cold storage and may show physiological breakdown or a collapse of the flesh if held in common storage. In fruit from the northern apple-growing regions there is relatively little danger of Ben Davis being picked too late, so long as severe freezing weather is avoided.

DELICIOUS

The Delicious is grown over a wide range of climatic conditions, and its best time for picking will vary somewhat in different sections of the country. High development of red color is extremely desirable in this variety, and it is sometimes left on the trees so long in order to obtain good color that the storage quality is injured. On the other hand, if picked when too immature Delicious is of extremely poor dessert quality.

In the Pacific Northwest and in the southern section of the eastern United States the pressure test is an excellent index of the time when this variety is approaching picking condition. If the best storage fruit is to be obtained, the fruit should be picked when it reaches a pressure test of 16 pounds, with 18 pounds down to 16 pounds representing the best picking range. Ground color in these districts will usually correspond to No. 3, Plate 1. At that time the fruit will pick easily. Delicious as grown in these long-season districts also has a tendency to water core, particularly if left on the tree until late. This development is usually an indication that the variety is ready to remove from the tree. There is also a distinct yellowing in the flesh of Delicious when it is in proper picking condition.

Since this variety usually requires about 145 days to reach picking maturity, it is well adapted to certain of the northern apple-growing districts. In these districts the fruit is usually firmer when in proper condition for picking, pressure testing about 18 pounds and showing a ground color comparable with 3½ to 4. Under these short-season conditions the ease with which the fruit may be picked and the

ground color are the best indications of when to remove the crop. The fruit separates from the tree easily when mature, and if not harvested promptly a considerable portion of the crop may drop.

This variety holds for a long season in a firm, crisp condition if moved at once into storage at 32° F. following harvest. It softens and becomes mealy with extreme rapidity, however, when handled at higher temperatures; consequently it is not well suited to handling in common storage, and any delay between date of picking and placing fruit under refrigeration will greatly decrease the time the fruit will remain in good condition in cold storage.

The variety does not scald badly, although a limited amount of storage scald may develop. If harvested in the condition outlined above, however, there is relatively little danger of storage scald.

ESOPUS SPITZENBERG

Esopus Spitzenberg does not develop scald in storage to any appreciable degree. It is, however, one of the worst varieties so far as wilting or shriveling in storage is concerned. It is desirable to have it well colored and well matured to reduce shriveling to a minimum. Even under these conditions the variety must be stored under high humidity if wilting in storage is to be avoided.

This fruit varies considerably as to ground color, the development of red color, and the firmness of the flesh, depending upon growing conditions. To obtain the best color for well-grown fruit it is safe to leave it on the tree until the pressure test is as low as 18 pounds. The color of the unblushed portion of well-grown fruit should correspond to Nos. 3 to 4, Plate 1. The fruit should separate from the tree easily when in good picking condition, although the variety does not have a marked tendency to drop. Water core develops in the warmer growing regions if picking is delayed too long. There is also a tendency for the fruit to crack at the stem end, especially if picking is delayed.

This variety ripens rapidly at high storage temperatures. Consequently, if long storage holding is desired, it is essential that the fruit be moved to cold storage very soon after picking. The storage period for this variety is largely determined by the amount of shriveling.

GANO AND BLACK BEN

So far as discussion of picking maturity is concerned, Gano and Black Ben may be treated together. They are susceptible to storage scald if picked in an immature condition. As a consequence, it is necessary that the fruit remain on the tree until practically full colored in order to obtain best storage quality. These varieties take on a very high color, and the fruit can generally remain on the tree until it is almost 100 per cent red. Unblushed portions of fruits should be practically of the full color corresponding to No. 4, Plate 1, when the fruit is in best picking condition.

In the long growing season districts, a pressure test of about 18 pounds will indicate when the fruit is in best storage condition. These fruits usually hold on to the tree very well, but should dropping begin before the fruit reaches the color condition and the pressure test suggested it is, of course, essential that it be harvested.

GRIMES GOLDEN

Grimes Golden tends to scald badly in storage, particularly if picked in a somewhat immature condition. If picked while the fruit is still a marked green color corresponding to Nos. 1 or 2, Plate 1, and then moved promptly to cold storage, this variety softens in storage without attaining the golden yellow color which is so desirable on the retail market. Consequently, in order to obtain the best appearance in the fruit, a high degree of resistance to scald, and the best dessert quality, this variety should not be picked before its color corresponds to No. 3, and it may well be left on the tree somewhat longer even than this if dropping is not excessive. This will usually be about 145 to 150 days from date of full bloom.

In most sections of the United States Grimes Golden is picked somewhat earlier than is desirable for the best storage and dessert quality fruit. It is generally picked at a pressure test of about 20 pounds, but if left on the trees until it attains a test of 18 pounds it will hold up practically as well in storage and be larger, better quality fruit with less tendency to scald. The color of the fruit, the pressure test, and the way the fruit is holding on the tree are all valuable indications of the proper picking condition of this variety.

JONATHAN

Jonathan usually requires about 140 to 145 days between the time of full bloom and the time when the fruit is in prime picking condition. Thus, in southern sections and in the Pacific Northwest it becomes a fall variety; in the short-season districts, such as Michigan and New England, it becomes an excellent winter-storage variety, being well adapted to holding even in air-cooled storage.

Jonathan, particularly as grown under long-season conditions, is a variety which must be picked in just the right condition if good marketable fruit combined with good storage quality is to be obtained. It is desirable to leave the fruit on the tree long enough to get high color, but if it is left on the tree too long under long growing season conditions it quickly becomes overripe in storage. If the variety is too mature when picked, "Jonathan breakdown" or the total collapse of the flesh is very likely to occur in storage, particularly in fruit delayed prior to moving into cold storage or held in air-cooled storage.

Jonathan has a noticeable tendency to water core as the fruit becomes overmature on the tree. Badly water-cored fruit of this variety usually has very poor storage quality. The development of appreciable water core is an indication that the fruit should be picked.

If the Jonathan is produced in sections having a long growing season, where the variety ripens during warm weather, it should be picked when showing an average pressure test of about 16 pounds. When the pressure test drops to 15 pounds or under, fruit of much less satisfactory storage quality is likely to result. The color of the unblushed portion of the fruit should at least correspond to No. 3, Plate 1, when in prime picking condition. Under these long growing season conditions the loosening and dropping of the fruit from the tree is not a reliable criterion of picking maturity, since the fruit may be in best picking condition while still holding well on the tree.

This variety grown in regions having a shorter growing season, such as Nebraska, Iowa, northern Illinois, northern Ohio, and territory to the northward, is not so likely to break down in storage. Fruit from these districts may safely be left on the tree until the ground color of the fruit corresponds to No. 4 and until the apples are highly colored. The ground color and the loosening of the fruit on the trees are probably the best indexes to the time of picking under these northern conditions. Fruit in these sections will generally test from 16 to 18 pounds at picking time.

KING DAVID

King David is most susceptible to scald in storage. It usually develops very high color, and it is desirable if possible to leave the fruit on the tree until it attains this high degree of color.

For best storage and dessert quality the fruit should be left on the tree until the ground color corresponds to Nos. 3 to 4, Plate 1. This variety may be left on the tree with safety until the pressure test reaches an average of 18 pounds. The variety has a rather marked tendency to drop when it reaches proper picking condition.

Because of its high color development and the fact that fruit picked when immature has fairly good storage quality, there is an inclination, particularly in the early shipping districts, to pick this apple somewhat too early. Better dessert quality and equally good storage quality will be realized from picking somewhat later than is generally practiced at the present time.

McINTOSH

The McIntosh appears to be almost immune to the development of storage scald, consequently it is not essential to leave the fruit on the tree until late in order to obtain good storage quality. High color commands a premium, however, so the variety should be left on the tree long enough to attain high color. This variety is not susceptible to water core. It has, however, a noticeable tendency to loosen and drop from the tree if left a little beyond the prime picking season.

When in best condition for picking, the McIntosh will usually show a pressure test of 15 to 16 pounds and a ground color between Nos. 3 and 4, Plate 1. If the fruit reaches this condition and is still poorly colored, it will be fairly satisfactory for storage if left on the tree until the pressure test is as low as 14 pounds. Excessive dropping may, of course, necessitate harvesting before this condition is reached.

The dropping of the fruit and its stage of color development are the main considerations in determining when to pick the McIntosh for marketing. Fruit picked at 15 to 16 pounds pressure will hold in storage somewhat better than softer fruit. This variety softens very rapidly at high temperatures, and it is very essential that the fruit be placed under refrigeration quickly after harvest if good storage quality is to be assured.

NORTHERN SPY

The Northern Spy, like the McIntosh, is not susceptible to storage scald, and the development of water core is also rather rare. The

variety usually holds on to the tree well and so may be allowed to remain rather late in order to get the best color development.

In the sections where there are cool, short growing seasons, to which the Northern Spy is best adapted, the fruit may be handled in common storage with very good results. For fruit to be held in common storage it is particularly desirable that picking be delayed as late as possible, since the fruit softens less while on the tree than in storage at prevailing temperatures. Color and the marketability of the fruit are also improved by this late picking. The Northern Spy is usually in best picking condition for storage when showing a pressure test of 16 to 17 pounds. The ground color of the fruit is usually at a stage corresponding to Nos. 2½ to 3, Plate 1, when in this picking condition. For cold storage the variety may be picked whenever the color and size are satisfactory, but for common storage the fruit should remain on the tree until late if best results are to be obtained.

If the variety is picked while very soft, it is essential that it be handled carefully in order to avoid bruising. If the fruit is sufficiently mature to show a pressure test under 16 pounds, it is often very severely bruised in heading barrels. Great care in this operation is essential if best storage results are desired.

RHODE ISLAND GREENING

The Rhode Island Greening scalds badly in storage, and the commercial cold-storage life of the variety is largely limited by this trouble. Since this variety is grown primarily in regions where apples are barreled, its susceptibility to scald is a very important consideration in determining the correct time for picking.

As the variety is green and there is no incentive for leaving it on the tree in order to obtain color, it is generally picked relatively early in the districts where it is grown. Undoubtedly this fruit is picked in a somewhat more immature condition than is most suitable for storage fruit, particularly considering its extreme susceptibility to scald when picked at an immature stage. The variety should generally be left on the tree until corresponding in color to No. 2, Plate 1, and until the fruit is very loose on the tree. It is now generally picked at a pressure test of 20 to 22 pounds. It appears certain that if left on the tree until testing 18 to 20 pounds the fruit could be held in storage with much less tendency to scald and could still be held in cold storage until well into the spring without becoming overripe. The variety softens rapidly at high temperatures and should be removed promptly to cold storage if a long storage season is desired.

ROME BEAUTY

The Rome Beauty has a pronounced tendency to scald in storage, particularly if picked in a somewhat immature condition, and when grown under the conditions of a moderately long growing season, to which this variety appears to be best adapted. The fruit tends to water core if left on the tree too long. The tendency to scald is an important consideration in determining time of picking, if the fruit is not to be packed in oiled paper. If the fruit is to be packed

in oiled paper, the color, the tendency to develop water core, and the firmness of the flesh are the best indexes to picking condition. This variety holds on the tree well, so that little dropping is probable even after the fruit has passed prime condition. Large size is extremely desirable in this variety, since the fruit is used largely for baking. Late picking results in larger sized fruit.

The ground color of this variety should agree with Nos. 3 to 4 of Plate 1 when the fruit is picked, with the pressure test not lower than 17 pounds, if best storage fruit is desired. If the fruit is softer than this at the time of picking, it will ripen and become mealy relatively early in storage. If the fruit is not to be packed in oiled wraps, it should not be picked before the ground color reaches approximately No. 4. If placed in oiled wraps it may be picked whenever the size and the amount of red color on the fruit are satisfactory.

This variety should be watched for the development of water core, and when an appreciable amount is present it is time to remove the fruit from the tree. A small amount of water core will apparently disappear while the fruit is in storage, and no serious results will follow; but if water core is severe it will result in an early breakdown of the fruit.

The Rome Beauty has a marked tendency to become mealy in storage and should be handled promptly and placed in cold storage quickly after picking, if long storage holding is desired.

STARK

The Stark, produced in the cooler, shorter growing season districts, is an excellent common-storage fruit. Tests during two seasons have indicated that, to obtain the best results in common storage, this variety should be left on the trees until very late. It will usually remain on the trees fairly well until toward the end of October or even the first of November in these districts. Generally, the later the fruit has been picked the firmer is its condition at any time during the common-storage season.

This variety is normally picked at a pressure test of 20 pounds or slightly above. If the fruit is to be handled through common storage, however, it may remain on the tree until testing as low as 18 pounds, and the benefit from the later, cooler picking season will more than offset the softer condition of the fruit.

The ground color of this variety when in good picking condition will usually correspond to Nos. 2 to 3, Plate 1. The loosening of the fruit on the tree is one of the best indexes of this variety's suitable picking condition. The dropping of the fruit may, in some cases, necessitate picking earlier than is otherwise desirable.

STAYMAN WINESAP

Stayman Winesap scalds very badly if picked in a somewhat immature condition and packed without the use of oiled paper. High color is very desirable in this variety, so that, from the standpoint of both scald resistance and best appearance of the fruit, relatively late picking is desirable. There is a tendency to develop water core, however, if the variety remains on the tree too long.

If this variety is packed in oiled paper it may be picked as soon as color development is satisfactory. For the best storage results it

should not be left on the tree until the pressure test is below 16 pounds. Fruit testing between 16 and 18 pounds has been found very satisfactory for storage. The ground color of the fruit generally should correspond to No. 3, Plate 1. Sometimes the variety softens, however, while the ground color is still green, so that the latter is not an infallible index to time of picking. This is particularly likely to occur if the fruit is ripening during very warm weather. In general it may be said that this variety can stay on the tree until the pressure test reaches 16 pounds or slightly less without serious injury to the storage quality. If appreciable water core begins to develop the fruit should be picked.

Delayed picking is desirable to obtain high color, good size, and dessert quality. If the variety is not packed in oiled paper, it is essential that it remain on the tree as long as it will hold satisfactorily, in order to reduce the development of scald to a minimum. The pressure test and under certain conditions the development of water core are perhaps the most dependable indexes to picking maturity.

Stayman Winesap ripens relatively rapidly after being removed from the tree; so, if long keeping is desired, it is essential that the variety be placed under refrigeration immediately.

WAGENER

The Wagener variety is extremely susceptible to scald while in storage and also to water core while on the tree. In general, in order to attain high color and the greatest resistance to storage scald, the fruit should be left on the tree until it is very loose and dropping or until water core has developed to a very appreciable extent.

This variety is well adapted to a short season in air-cooled storage in the shorter growing season districts. If intended for common-storage holding, it should remain on the tree as long as possible or until water-core development becomes serious. If intended for cold-storage holding, late picking is also desirable unless oiled paper is used. If placed in cold storage after packing in oiled paper, picking when the fruit shows a pressure test of around 18 pounds or slightly above will apparently give very satisfactory results.

WINESAP

The Winesap has a long growing season, usually requiring about 165 to 170 days between the date of full blossoming and the picking date in order to reach its best development. It is one of the very best varieties for long-storage holding, softening relatively slowly in storage. If placed at once in cold storage following picking and held at a temperature of 30° to 32° F., the Winesap will hold through until late spring in a crisp, firm condition.

The Winesap has a rather pronounced tendency to scald late in the season if not placed in oiled paper. Consequently, if this precaution is not taken, this variety should remain on the trees as long as it will hold without excessive dropping, in order to reduce storage scald to the minimum.

The Winesap usually colors very highly, and high color is essential to its most advantageous marketing. This is obtained to best

advantage by leaving the apples on the tree as long as they are holding satisfactorily.

Finally, the marketing of the Winesap is usually improved by large size, the fruit of this variety generally being smaller than is desired in the markets. The fact that the fruit is increasing in size as long as it is held on the tree makes late picking advantageous from the marketing viewpoint.

The Winesap tends to drop rather badly when it reaches proper picking condition, and this is one of the best indexes of the time to pick the fruit. If the variety is ripening during warm weather the fruit tends somewhat to water core; therefore as the fruit approaches picking condition the development of water core should be watched. In general, it may be said, however, that as long as the Winesap is holding on the tree well its storage quality is not becoming poorer, while its size, color, and resistance to scald are improving. When considerable water core begins to develop or when the apples begin to drop to a marked extent, it is desirable that the fruit be picked.

In general, the ground color of the Winesap will be very nearly the color shown as No. 4, Plate 1, and the pressure test will be 19 pounds or above when the fruit is in best picking condition. There is relatively little danger of this variety becoming too ripe on the tree for good storage quality. For long holding in cold storage the fruit should be placed in storage at an early date following picking. If held in common storage the Winesap, in common with other late-keeping varieties, ripens less while on the tree than in common storage at prevailing temperatures, and the later picking is delayed the better the storage quality of the fruit.

WINTER BANANA

The Winter Banana (*Banana*) variety has a relatively short growing season, usually reaching picking condition in approximately 120 to 125 days from date of blooming. Thus in the southern apple districts, and in the Pacific Northwest where the growing season is long, this variety is an early fall apple and usually is not held in cold storage for very long periods. It is capable of considerable storage holding, however, if placed at once at 32° F.

This variety is firm at time of picking, as shown by the pressure test. Optimum picking condition has generally been found to be about 20 pounds with a color corresponding to No. 3, Plate 1. Because the fruit does not scald badly in storage, it may be picked as early as it will develop good quality. Fruit picked when too immature, however, is very susceptible to bitter pit, particularly in the Pacific Northwest. A pressure test of 20 pounds and a color corresponding to No. 3 at picking time has generally resulted in the fruit being of good quality for eating and of very satisfactory storage quality. Usually by the time this color stage and pressure-test stage have been reached the fruit will separate readily from the spur, which is a further indication of proper picking condition. Under good growing conditions, the skin should be a clear yellow-green color at picking time. If picked when too green, corresponding to color 1 or 2, the fruit will not develop the clear, almost transparent yellow color which makes the variety so attractive in appear-

ance. There is a rather marked relation between soil and cultural conditions and the time of maturity in this variety.

Winter Banana is extremely susceptible to water core when grown in the Pacific Northwest or in the southern apple sections of the Eastern States, if it becomes overmature on the tree. When a considerable quantity of water core begins to develop, the fruit should generally be picked.

With well-grown fruit the yellowing of the unblushed portion until it corresponds to No. 3 is usually the most dependable test for time of picking.

YELLOW NEWTOWN

The Yellow Newtown (*Newtown Pippin*, *Albemarle Pippin*) is a variety similar to the Winesap in requiring a rather long growing season—165 to 170 days—to reach best development. Though it is not necessary to leave this variety on the tree late in order to obtain color, the fruit tends to scald late in the storage season if not packed in oiled paper. Consequently, late picking is desirable when oiled paper is not used in packing. The Yellow Newtown adheres to the tree well, usually not showing an appreciable dropping of the fruit even if left on the tree until somewhat past the best picking season.

Color changes in the Yellow Newtown are not sufficiently marked to serve satisfactorily as an index to time of picking. The variety is usually green, corresponding to Nos. 1 to 2, Plate 1, but may be considerably more yellow than this, particularly if grown in sod or under conditions of low nitrogen supply.

Some variation is usually allowable in the time of picking the Yellow Newtown, but the fruit should not be allowed to become too ripe on the tree if best storage quality is desired. This variety, picked when testing about 20 pounds or slightly under, will usually combine high dessert quality with excellent storage condition. If the fruit is not to be packed in oiled paper it may become somewhat softer than this while on the tree, testing down to 18 pounds without injury to the storage quality, since resistance to scald will be improved. For fruit to be placed in cold storage, however, and packed in oiled paper, picking at a pressure test of about 19 to 20 pounds will give best results.

Certain strains of Yellow Newtown have been noted in which the fruit reaches picking condition some three to four weeks earlier than the normal variety does. Some of these strains are in the commercial orchards, and if all the fruit is picked at the same time the early-ripening strain will have very poor storage quality as compared with the late-ripening fruit. These strains usually show a pressure test of 2 to 4 pounds less than the variety as a whole at any date during the late growing season. If trees of these early-ripening strains are present in the orchards they should be marked and the fruit harvested separately, since this fruit will have inferior keeping quality and will detract greatly from the general pack if the fruit is mixed.

For holding in air-cooled or common storage, late picking of the Yellow Newtown has the same advantages pointed out for the other long-keeping varieties. The fruit softens less rapidly on the tree

than while being held at prevailing outdoor temperatures. Consequently, delaying the picking of this variety as long as possible will improve its keeping quality if the fruit is handled through air-cooled storage.

YORK IMPERIAL

The York Imperial is similar to the Arkansas in that its possible storage life is determined almost entirely by the development of storage scald. Consequently, picking at the latest possible date is particularly essential in this variety. The fruit softens slowly in both cold and air-cooled storage. In cold storage particularly the fruit usually shows storage scald while still firm, and even in air-cooled storage the possible holding date is usually determined by scald development rather than by the maturity of the fruit.

In general, it may be stated that the later the York Imperial is picked the better its storage quality will be. Unfortunately, this variety tends to drop very badly during certain seasons, so that picking is often necessary before the fruit reaches best storage condition. If the fruit is holding on the tree, it should be left until the ground color attains a shade corresponding to No. 3, Plate 1. When the fruit reaches this condition the pressure test will usually be about 19 pounds. The fruit often begins to drop so badly, however, that picking is necessary before it reaches this condition.

For holding in common storage or air-cooled storage, it is particularly desirable that the fruit be held as long as possible before picking. The York Imperial is a very satisfactory variety for holding in air-cooled storage, since it will remain firm for a considerable period even if held at moderately high temperatures. Late picking for common-storage fruit is advisable, however, since not only the resistance to scald but the color and texture of the fruit are improved by the relatively late picking.

RELATION OF TIME OF PICKING TO HANDLING

It should be noted that when the different varieties remain on the trees until late, or until the flesh is soft, they become very sensitive to mechanical injury. Stayman Winesap, Delicious, and Jonathan testing 16 pounds or under are not only easily bruised but are extremely susceptible to stem puncture and other mechanical injuries. The same is true of the Northern Spy and also of the McIntosh when in the riper condition noted as suitable for picking. When harvesting is delayed for any reason, particularly with these tender-fleshed varieties, unusual care in handling is essential.

SUMMARY

Many factors enter into the determination of the best time to harvest different varieties of apples. The susceptibility to storage scald or to internal breakdown in storage is an important factor in determining when to pick any variety. Susceptibility to water core while on the trees, the amount of red color which has developed, the size of the fruit, and the tendency to drop are all important considerations. The time of picking may well be varied somewhat with the type of storage to be used.

The firmness of the flesh of the fruit, the amount of yellowing in its unblushed portions, and the tenacity with which it is holding on the trees are perhaps the most dependable indexes to picking maturity.

The factors entering into a consideration of the best time to pick different varieties and the stage of maturity which has been found to give most satisfactory storage and market fruit are discussed in detail for most of the important commercial storage varieties.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

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